TRANSMITTAL FORM

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ATTORNEY DOCKET NO.	
70014.0013US01	
U.S. APPLICATION SERIAL NO.	CONFIRMATION NO.
09/975,257	8852
FILING DATE	
October 12, 2001	

INVENTOR(S)	EXAMINER	TECHNOLOGY CENTER	GROUP ART UNIT
Sundar NARAYANAN et al.	Heather Anne Doty	2800	2813

TITLE OF APPLICATION

NOVEL SELF MONITORING PROCESS FOR ULTRA THIN GATE OXIDATION

ADDRESS TO:	Mailstop Appeal Brief-Patents Commissioner for Patents P.O. BOX 1450 ALEXANDRIA, VA 22313-1450

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- ☒ **Fee Transmittal (In Duplicate)**
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CORRESPONDENCE ADDRESS

☒ The address associated with Customer Number: **23552** *OR* ☐ the correspondence address below.

Name

Address

City *State* *Zip Code*

NAME	Christopher W. Raimund	REGISTRATION NO.	47,258		
SIGNATURE	Brian Lathrop	DATE	December 11, 2006	TELEPHONE	202 326-0300
NAME	Brian K. Lathrop	REGISTRATION NO.	43,740		

FEE TRANSMITTAL

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TECHNOLOGY CENTER	2800
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TITLE OF APPLICATION: NOVEL SELF MONITORING PROCESS FOR ULTRA THIN GATE OXIDATION

☐ Applicant claims small entity status. See 37 CFR 1.27. Certain fees are reduced by 1/2.

TOTAL AMOUNT OF PAYMENT: $500.00

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The following fees have been submitted:

APPLICATION FEES

	FEE CODE	DESCRIPTION	FEE	CALCULATE
☐	1011	Basic Filing Fee - Utility	$300.00	
☐	1111	Utility Search Fee	$500.00	
☐	1311	Utility Examination Fee	$200.00	
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☐	1801	Request for Continued Examination	$790.00	
☐	1814	Terminal Disclaimer	$130.00	
☐	1452	Petition to Revive Unavoidably Abandoned Application	$500.00	
☐	1453	Petition to Revive Unintentionally Abandoned Application	$1,500.00	
			SUB TOTAL	$ 0.00

EXTENSION OF TIME FEES

	FEE CODE	DESCRIPTION	FEE	SUBMITTED
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☐	1252	Extension for Response Within the Second Month	$450.00	
☐	1253	Extension for Response Within the Third Month	$1,020.00	
☐	1254	Extension for Response Within the Fourth Month	$1,590.00	
☐	1255	Extension for Response Within the Fifth Month	$2,160.00	
Credit for Extensions Previously Paid				
			SUB TOTAL	$ 0.00

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☐ Additional Fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) or computer program listing in an electronic medium) (37 CFR 1.492(j)). The fee is **$250** for each additional 50 sheets or fraction thereof.

Total Sheets	Extra Sheets	Number of each additional 50 sheets or fraction thereof (round up to whole no.)	RATE	
0-100	/50=		x $250.00 =	$0.00

DOCKET NO.	U.S. APPLICATION SERIAL NO.	FILING DATE
70014.0013US01	09/975,257	October 12, 2001

CLAIM FEES

CLAIMS	NUMBER FILED	NUMBER PREV. PAID FOR		MAX. PAID	NUMBER OF ADD'L CLAIMS	RATE		
Total Claims	0		☒	20		x $50	$0.00	$0.00
Independent Claims	0		☒	3		x $200	$0.00	
☐ MULTIPLE DEPENDENT CLAIM(S)						+ $360	$0.00	
						TOTAL OF ABOVE CALCULATIONS =		

APPEALS/INTERFERENCE FEES

	FEE CODE	DESCRIPTION	FEE	SUBMITTED
☐	1401	Notice of Appeal	$500.00	
☒	1402	Filing a Brief in Support of an Appeal	$500.00	$500.00
☐	1403	Request for oral Hearing	$1,000.00	
			SUB TOTAL	$ 500.00

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	FEE CODE	DESCRIPTION	FEE	SUBMITTED
☐	1501/1511	Utility/Reissue Issue Fee	$1,400.00	
☐	1502	Design Issue Fee	$800.00	
☐	1503	Plant Issue Fee	$1,100.00	
			SUB TOTAL	$ 0.00

	TOTAL OF FEES SUBJECT TO REDUCTION FOR SMALL ENTITY STATUS	$500.00
☐	Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by 1/2.	x 1.00= $500.00

FEES NOT SUBJECT TO REDUCTION FOR SMALL ENTITY STATUS

POST-ISSUANCE FEES

	FEE CODE	DESCRIPTION	FEE	SUBMITTED
☐	1811	Certificate of Correction	$100.00	
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☐	1053	Non-English Specification		$130.00	
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☐	8021	Recording Assignment, Agreement or Other Paper	0 properties x	$40.00	
☐	1504/1505	Publication/Republication Fee		$300.00	
				SUB TOTAL	$ 0.00

TOTAL FEES SUBMITTED	**$500.00**

NAME	Christopher W. Raimund		REGISTRATION NO.	47,258	
SIGNATURE	Brian Lathrop	DATE	December 11, 2006	TELEPHONE	202 326-0300
NAME	Brian K. Lathrop		REGISTRATION NO.	43,740	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPELLANTS' APPEAL BRIEF		ATTORNEY DOCKET NO. **70014.0013US01**	
		U.S. APPLICATION SERIAL NO. **09/975,257**	CONFIRMATION NO **8852**
		FILING DATE **October 12, 2001**	
INVENTOR(s) **Sundar NARAYANAN et al.**	EXAMINER **Heather Anne Doty**	Technology Center **2800**	GROUP ART UNIT **2813**
TITLE OF APPLICATION **NOVEL SELF MONITORING PROCESS FOR ULTRA THIN GATE OXIDATION**			

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Brief is presented in support of the Notice of Appeal filed October 10, 2006, from the final rejection of Claims 1-3, 5-19 and 23 of the above-identified application, as set forth in the Final Office Action mailed April 11, 2006.

Please charge Deposit Account No. 13-2725 in the amount of $500.00 to cover the required fee for filing this Brief.

An oral hearing is requested. A separate request for oral hearing with the appropriate fee will be filed within two months of the Examiner's Answer.

I. REAL PARTY OF INTEREST

The real party of interest is Cypress Semiconductor Corporation.

II. RELATED APPEALS AND INTERFERENCES

There are no other prior or pending appeals, interferences or judicial proceedings that may be related to, directly affect, be directly affected by, or have some bearing on the Board's decision.

III. STATUS OF CLAIMS

Claims 1-3, 5-19 and 23 are rejected; Claims 4 and 20-22 are cancelled. The claims on appeal are Claims 1-3, 5-19 and 23. A copy of the claims is attached hereto as the Claims Appendix.

IV. STATUS OF AMENDMENTS

The amendment filed August 17, 2006 after final rejection will be entered for the purpose of appeal, as noted in the Advisory Action mailed September 5, 2006.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The invention provides a method of determining the nitrogen content of an oxide layer in a semiconductor device. Specification, p. 1, ll. 6-8. Semiconductor devices may be fabricated by placing a gate electrode on a silicon substrate wafer. *Id.*, p. 1, ll. 10-13. The gate electrode is insulated from the silicon substrate by an intervening "gate oxide layer," made from silicon dioxide (SiO_2), for example. *Id.*, p. 1, ll. 11-15. FIG. 1A, for example, depicts a SiO_2 gate oxide layer **12** on the silicon wafer substrate **14**. (The gate electrode, which is positioned on the SiO_2 layer **12**, is not depicted in FIG. 1). *Id.*, FIG. 1A; p. 6, ll. 6-8; p. 8, ll. 14-16.

Gate electrodes can be doped with boron or other dopants to improve device performance. These dopants, however, can penetrate the gate oxide layer and silicon wafer, where they exert detrimental effects on the device characteristics. *Id.*, p. 1, ll. 17-19; p. 2, ll. 1-17. Increasing problems with dopant penetration, particularly in devices with ultrathin layers, have driven the search for new materials and methods for future semiconductor applications. One method of retarding dopant penetration is nitridation of the gate oxide layer. *Id.*, p. 2, ll. 18-22. The nitrided gate oxide layer formed at the interface of the gate oxide layer and silicon substrate is depicted by element **16** in FIG. 1B. *Id.*, FIG. 1B; p. 6, ll. 8-9; p. 8, ll. 17-19.

Nitrogen in the gate oxide layer thus has beneficial effects on the electrical properties of semiconductor devices, related to the suppression of dopant penetration. Clearly, commercial fabrication of semiconductor devices would benefit from a rapid, accurate, and reproducible method of determining the nitrogen content of the nitrided gate oxide layer. This nitrogen content, however, is difficult to measure, in part because of the small relative thickness of the layers of the device. *Id.*, p. 3, ll. 10-13.

To solve this problem, the claimed invention provides a method for determining the nitrogen content of the nitrided gate oxide layer that comprises using NO gas to form the nitrided gate oxide layer on the substrate and oxidizing the nitrided gate oxide layer, where the oxidizing distances the nitrided gate oxide layer away from the semiconductor substrate. *Id.*, p. 4, ll. 5-11; p. 6, l. 19 – p. 7, l. 6; p. 9, ll. 13-15; p. 13, ll. 4-6. As shown in FIG. 1C, for example, the oxidized nitrided gate oxide layer **18** develops between the nitrided gate oxide layer **16** and the silicon substrate **14**. Specification, p. 6, ll. 9-10; p. 8, ll. 19-22. Important advantages of distancing the nitrided gate oxide layer away from the semiconductor substrate include improved carrier mobility and device speed, as well as improved threshold voltage and boron penetration properties of the gate oxide layer. *Id.*, p. 13, ll. 6-13.

In the claimed method, the thickness of the oxidized nitrided gate oxide layer (element **18** in FIG. 1C) is measured, providing a determination of the nitrogen content of the nitrided gate oxide layer (element **16** of FIG. 1C). *See, e.g., id.*, p. 9, l. 19 – p. 7, l. 6. The method of Claim 1 comprises determining if the measured thickness or calculated change in thickness of the oxidized nitrided gate oxide layer exceeds a target thickness value. *Id., et seq.* The method of Claim 10 similarly comprises determining if the measured thickness or calculated change in thickness exceeds a target thickness value, where calculating the change in thickness comprises determining an initial gate oxide thickness by estimating the thickness of the gate oxide layer prior to the oxidation step and calculating the difference between the measured oxidized nitrided gate oxide layer thickness and the initial gate oxide thickness. *See, e.g., id.*, p. 10, l. 19 – p. 11, l. 6. The invention of Claim 19 comprises using a computer in communication with the film thickness measuring device, where the computer *inter alia* computes a batch average value for the thickness of the oxidized nitrided gate layer. *See, e.g., id.*, p. 13, l. 19, *et seq.*

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 3, 5-12, 17 and 18 stand rejected under 35 U.S.C. § 103(a) as being obvious over JP 2000-311928 ("Yasushi") in view of U.S. Patent No. 6,372,581 ("Bensahel").

Claim 2 and 13-16 stand rejected under 35 U.S.C. § 103(a) as being obvious over Yasushi in view of Bensahel as applied to Claims 1 and 12, and further in view of Wolf *et al.*, "Silicon Processing for the VLSI Era," Vol. 1-3, Lattice Press, CA (1990) ("Wolf").

Claim 19 stands rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,862,054 ("Li") in view of Yasushi and Bensahel.

Claim 23 stands rejected under 35 U.S.C. § 103(a) as being obvious over Li in view of Yasushi and Bensahel as applied to Claim 19, and further in view of Wolf.

VII. ARGUMENT

A. Rejection of Claims 1, 3, 5-12, 17 and 18 under 35 U.S.C. § 103(a) as being obvious over JP 2000-311928 ("Yasushi") in view of U.S. Patent No. 6,372,581 ("Bensahel"):

Regarding Claim 1, the Examiner alleges that Yasushi teaches a method of determining the nitrogen content of a nitrided gate oxide layer on a semiconductor substrate, comprising all the elements of the claimed invention, save two. Final Office Action, mailed April 11, 2006, p. 2, ¶ 3 – p. 3, ¶ 2. First, the Examiner admits that Yasushi does not teach a method comprising "nitriding a gate oxide layer on a semiconductor substrate using nitric oxide (NO) gas to form the nitrided gate oxide layer on the substrate," as claimed *Id.*, p. 3, ¶ 3. Second, the Examiner admits that Yasushi is silent with respect to whether "oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the semiconductor substrate," as claimed. *Id.*, p. 2, ¶ 5.

(1) The rejection erroneously discounts teachings in Bensahel and in the art of record that would have led the artisan of ordinary skill away from practicing the claimed method.

The Examiner alleges that Bensahel motivates substituting N_2O, as taught by Yasushi, with NO to nitride a gate oxide layer on a semiconductor substrate. *Id.*, p. 3, ¶¶ 4-5. It is well established that a prior art reference must be considered in its entirety, including portions that would lead away from the claimed invention. *See, e.g., W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1550, 220 U.S.P.Q. 303, 311 (Fed. Cir. 1983). As this Board's reviewing court has stated:

> The factual inquiry whether to combine references must be thorough and searching. It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with.

In re Lee, 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430, 1433 (Fed. Cir. 2002) (internal quotations and citations omitted).

Bensahel does not motivate one to use NO gas in a method comprising oxidizing the nitrided gate oxide layer, which distances the layer from the semiconductor substrate. To the contrary, Bensahel teaches that using NO gas for nitriding a gate oxide layer "does not allow the presence of nitrogen to be localized precisely at the interface between the substrate and the gate oxide layer (Si/SiO_2 interface)." Bensahel, col. 1, ll. 42-45. If the artisan would not have expected to localize nitrogen precisely at the interface of the support and gate oxide layer, how would the artisan have appreciated that the subsequent oxidation of the nitrided gate would distance the nitride layer from this interface? In fact, when Bensahel oxidizes a gate oxide layer nitrided ***with NO***, the nitrided layer **3** ***remains*** next to the substrate **1**, and the oxidized layer **4** accumulates ***on top*** of the nitrided gate oxide layer **3**, as depicted in FIG. 1D (Bensahel, col. 2, ll. 37-51; FIG. 1D):

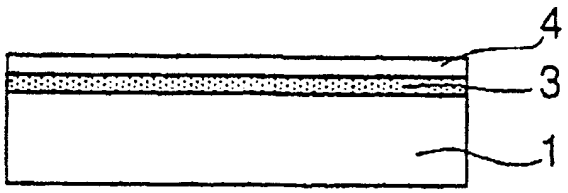

FIG. 1D of Bensahel

Accordingly, the artisan of ordinary skill, following the teachings of the combined references, would not have practiced a method according to the claims but would have practiced a method leading to the opposite result.

Further, the art of record undermines the rationale behind combining Yasushi and Bensahel for the reasons given by the Examiner. As taught in Gusev *et al.*, "Growth and

characterization of ultrathin nitrided silicon oxide films," *IBM J. Res. Develop.* 43: 265-86 (May 1999) (reference AI on the IDS filed July 3, 2002; hereinafter, "Gusev"), it was known in the art that there was a "fundamental difference" between the mechanism of nitridation with NO and N_2O gases. Gusev, p. 276, right col. In particular, "in the N_2O case the nitrogen incorporation occurs simultaneously with nitrogen removal from the upper layers of the film" (*Id.*, p. 276, right col.), leading to distinct distributions of nitrogen within the nitrided gate oxide layer, as depicted at numbered items 1 and 2 in FIG. 15. *Id.*, p. 278, FIG. 15. Gusev does not teach whether the oxidation of a gate oxide layer nitrided with either NO or N_2O would have distanced the nitrided gate oxide layer from the substrate. *Compare Id.*, p. 277, left col.; p. 278, FIG. 15 under item 3 (where apparently *both* NO and N_2O were used for nitridation). Gusev concludes that the two gases would have been expected to yield devices with different electrical properties (*Id.*, p. 277, right col.) (emphasis added):

> Since the reactivities of NO [and] N_2O . . . with Si, SiO_2, and SiO_xN_y are quite different, properly chosen sequences of thermal reactions with Si can lead to oxinitride films with different nitrogen concentrations and profiles, and therefore electrical properties.

From this teaching, the artisan of ordinary skill would have appreciated that NO and N_2O would not give equivalent results when used to nitride a gate oxide layer.

In response to Appellants' arguments, the Examiner states, "the rejections presented in this and the last Office action rely upon the teachings of Bensahel ***only*** to establish the obviousness of using NO instead of N_2O to nitride an oxide layer." Final Office Action, mailed April 11, 2006, p. 14, ¶ 3 (emphasis added). The Examiner, however, cannot discount the teachings in Bensahel discussed above that would have taught away from the claimed method, simply because the Examiner did not rely on those teachings in the stated rejection. *See Gore &*

Assoc., 721 F.2d at 1550, 220 U.S.P.Q. at 311; *Lee*, 277 F.3d at 1343, 61 U.S.P.Q.2d at 1433. The rejection is based on the faulty premise that the teachings of Bensahel would have motivated or suggested substituting N_2O in the procedure taught by Yasushi with NO to arrive at the claimed method. To the contrary, when Bensahel uses NO gas for nitridation, oxidation of the nitrided gate oxide layer gave the opposite result as claimed. Bensahel, col. 2, ll. 37-51; FIG. 1D. Further, the artisan of ordinary skill was aware that nitridation with NO and N_2O did not produce the same nitrogen profile in the nitrided gate oxide layer, and the artisan would not have known whether the subsequent oxidation of either nitrided gate oxide layer would distance the nitrided layer from the substrate. Gusev, p. 276, right col.; p. 278, FIG. 15; p. 277, right col. The Examiner cannot ignore the contrary teachings of Bensahel and the art as a whole. Accordingly, Appellants urge that the rejection be reversed.

In this context, the Advisory Action, mailed September 5, 2006, cites *In re Keller*, 642 F.2d 413, 425, 208 U.S.P.Q. 871, 881 (C.C.P.A. 1981) for the proposition that the test for obviousness is what the combined teachings of the references would have suggested to those of ordinary skill in the art. Advisory Action, p. 2. Nothing in the *Keller* decision, however, relieves the Examiner of considering the evidence on the record as a whole or conducting a searching inquiry of the evidence, which the court required in *Gore* and *Lee*.

(2) The rejection erroneously bases an obviousness rejection on an unrecognized, allegedly inherent characteristic of the cited art, and the rejection does not establish whether the allegedly inherent characteristic necessarily occurs.

The Examiner admits that Yasushi does not teach a method wherein "the step of oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the

semiconductor substrate," as currently claimed. Final Office Action, mailed April 11, 2006, p. 2, ¶ 5. Regarding this deficiency in Yasushi, the Examiner invokes the concept of inherency:

> Yasushi does not expressly teach this effect, but since Yasushi teaches reoxidizing the nitrided gate [in a] manner by heating the sample in an oxygen atmosphere—page 2, lines 6 – 8 of the translation—the same method disclosed by Applicant, ***it is inherent*** that the step of oxidizing the nitrided gate oxide layer taught by Yasushi will also distance the nitrided gate oxide layer away from the semiconductor substrate.

Id., p. 2, ¶ 5 (emphasis added).

If this rejection were under 35 U.S.C. § 102 for ***anticipation*** by the prior art, the Examiner would not have to produce evidence that the skilled artisan appreciated what was inherent in the prior art. *See Schering Corp. v. Geneva Pharms., Inc.*, 339 F.3d 1373, 1378-79, 67 U.S.P.Q.2d 1664, 1667 (Fed. Cir. 2003). The present rejection, however, alleges that the claims would have been ***obvious*** over the cited art, despite an absence of evidence that the artisan of ordinary skill would have appreciated that oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the semiconductor substrate. It is ***Appellants'*** appreciation of this very property that allows fabrication of semiconductor devices with improved carrier mobility, device speed, threshold voltage, and boron penetration properties, as disclosed, for example, in the specification at page 13, ll. 6-13.

It is reversible error to base an obviousness rejection on undisclosed, unrecognized, allegedly inherent properties of the cited references. *See, e.g., In re Rijckaert*, 9 F.3d 1531, 1534, 28 U.S.P.Q.2d 1955, 1957 (Fed. Cir. 1993) (holding that a retrospective view of inherency is no substitute for some teaching or suggestion in the art supporting an obviousness rejection); *In re Spormann*, 363 F.2d 444, 448, 150 U.S.P.Q. 449, 452 (C.C.P.A. 1966) ("[T]he inherency of an advantage and its obviousness are entirely different questions. That which may be inherent is

not necessarily known. Obviousness cannot be predicated on what is unknown."); *In re Antonie*, 559 F.2d 618, 620, 195 U.S.P.Q. 6, 8 (C.C.P.A. 1977) (holding an obviousness rejection improper, where the prior art did not reveal the property that applicants had discovered); *In re Newell*, 891 F.2d 899, 901, 13 U.S.P.Q.2d 1248, 1250 (Fed. Cir. 1989); *In re Grasselli*, 713 F.2d 731, 739, 218 U.S.P.Q. 769, 775-76 (Fed. Cir. 1983). Further, it is well established that inherency "may not be established by probabilities or possibilities." *In re Oelrich*, 666 F.2d 578, 581-82, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981).

The Examiner has pointed to no evidence in the record that demonstrates either that the artisan would have appreciated that oxidizing a gate oxide layer nitrided with NO would distance the nitrided gate oxide layer away from the semiconductor substrate, as claimed, or that this was necessarily an inherent property of the claimed process. To the contrary, Bensahel teaches that the oxidized nitrided gate oxide layer can accumulate ***on top*** of the nitrided layer. Bensahel, col. 2, ll. 37-51; FIG. 1D. Moreover, Gusev teaches that oxidation of a gate oxide layer nitrided with NO or N_2O would yield devices having different nitrogen concentrations and profiles, suggesting that the oxidation of a gate oxide layer nitrided with NO or N_2O likewise may produce devices with different nitrogen profiles. *See* Gusev, p. 277, right col. Because the Examiner cannot produce evidence on the record to support the rejection, and because the evidence on the record directly contradicts the basis for the rejection, the rejection is improper, and Appellants urge that the Board reverses the same.

(3) The rejection erroneously requires Appellants to "show that the chosen claim limitations are critical."

In response to Appellants' arguments, the Examiner relies on *In re Woodruff*, 919 F.2d 1575, 1578, 16 U.S.P.Q.2d 1934, 1936 (Fed. Cir. 1990) to impose a requirement on Appellants to "show that the chosen claim limitations are critical:

> However, the instant specification contains no disclosure of either the critical nature of the claimed process or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical.

Final Office Action, mailed April 11, 2006, p. 6, ¶ 4 (parenthetical and citation omitted), for example. *Woodruff* does not stand for this proposition; rather, the cited passage from *Woodruff* speaks to unexpected results and "criticality" in the context of a claim comprising a recited range that overlaps with a range for the same parameter found in the prior art. *See In re Woodruff*, 919 F.2d at 1577, 16 U.S.P.Q.2d at 1936. In the relevant holding, the court stated:

> The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. These cases have consistently held that in such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.

In re Woodruff, 919 F.2d at 1578, 16 U.S.P.Q.2d at 1936 (citations omitted); *see also* M.P.E.P. § 2144.05(III), 8th ed., revised October 2005 (discussing *Woodruff* in this context). The situation that *Woodruff* addresses simply is not present in this case; therefore, the Examiner's reliance on *Woodruff* is inapposite.

Nor do Appellants need to disclose unexpected results, as the Examiner implies. Unlike the situation in *Woodruff*, the rejection does not make a proper *prima facie* case of obviousness, for the reasons set forth above. Where *prima facie* obviousness is not demonstrated, it is

improper to require an applicant to rebut the rejection by showing unexpected results by declaration, and it certainly is improper to require Appellants to show unexpected results in the original disclosure. *See In re Spada*, 911 F.2d 705, 708, 15 U.S.P.Q.2d 1655, 1658 (Fed. Cir. 1990) (discussing a *prima facie* case as a procedural tool); *see also In re Geisler*, 116 F.3d 1465, 1469, 43 U.S.P.Q.2d 1362, 1365 (Fed. Cir. 1997). Accordingly, the requirement that Appellants "show that the chosen claim limitations are critical" is improper, and the rejection should be reversed.

The Advisory Action, presumably in this same context, alleges that the Appellants "do not *claim how* oxidizing the nitrided gate oxide layer on the substrate distances the nitrided gate oxide layer from the semiconductor substrate, as claimed in claim 1." Advisory Action, mailed September 5, 2006, p. 2 (emphasis added). The specification, which includes a working example, teaches the artisan how to practice the claimed method in compliance with 35 U.S.C. 112, ¶ 1. *See, e.g.*, Specification, p. 12, *et seq.* The cited portion of the Advisory Action suggests that the claims now must stand in the place of the specification, but this notion departs from established precedent, is provided without a reasoned explanation, and is proposed without supporting statutory or decisional authority. This requirement accordingly is not in accordance with 35 U.S.C. § 103.

B. Rejection of Claims 2 and 13-16 under 35 U.S.C. § 103(a) as being obvious over Yasushi in view of Bensahel as applied to Claims 1 and 12, and further in view of Wolf *et al.*, "Silicon Processing for the VLSI Era," Vol. 1-3, Lattice Press, CA (1990) ("Wolf"):

Claim 2 depends from Claim 1 and recites that the oxidizing step comprises oxidation of the nitrided gate oxide layer in a rapid thermal processing (RTP) chamber. Claims 13 and 14

depend from Claim 12, which likewise depends from Claim 1 and recites that the method further comprises a step of forming a gate electrode layer over the gate oxide layer. Claim 15 depends from Claim 1 and recites that the oxidation step is conducted at a temperature of 900 to 1025 °C, and Claim 16 depends from Claim 15.

The rejection does not allege that Wolf teaches, motivates or suggests the elements lacking in the combined teachings of Yasushi and Bensahel as applied to Claims 1 and 12, namely oxidizing the nitrided gate oxide layer on the substrate, where the step of oxidizing distances the nitrided gate oxide layer away from the semiconductor substrate. Instead, the Examiner relies on various teachings in Wolf that relate to the recited aspects of the dependent claims listed above. Final Office Action, mailed April 11, 2006, p. 8, ¶ 4 – p. 10, ¶ 4. Because the dependent claims incorporate all the limitations of Claims 1 or 12, the rejection likewise does not set forth a proper case of *prima facie* obviousness with respect to the dependent claims. Accordingly, Appellants urge the Board to reverse the present rejection, too.

C. Rejection of Claim 19 under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,862,054 ("Li") in view of Yasushi and Bensahel:

Li teaches the use of a computerized process monitoring system for real time statistical process control; however, the Examiner admits that Li does not teach or suggest, among other things, oxidizing a nitrided gate oxide layer on a semiconductor substrate, where the gate oxide layer was nitrided with NO and the oxidizing distances the nitrided gate oxide layer away from the substrate, as claimed. Final Office Action, mailed April 11, 2006, p. 11, ¶ 2. To correct this deficiency of Li, the Examiner combines the teachings of Yasushi and Bensahel, using the same rationale discussed above. *Id.*, p. 11, ¶ 3 – p. 12, ¶ 3. Accordingly, Li does not remedy the

deficiencies in the combination of Yasushi and Bensahel noted above, and the rejection should be reversed.

D. Rejection of Claim 23 under 35 U.S.C. § 103 (a) as being obvious over Li in view of Yasushi and Bensahel as applied to Claim 19, and further in view of Wolf:

Claim 23 depends from Claim 19. Since the Examiner has not made a proper case of *prima facie* obviousness against Claim 19, the rejection of Claim 23 should be reversed, as well. Specifically, the Examiner invokes the teachings of Wolf solely as they relate to implanting boron in a gate electrode layer. Id, p. 13, ¶ 3. Since these teachings do not correct the deficiencies of the combined teachings of Li, Yasushi and Bensahel, noted above, the rejection is improper and accordingly should be reversed.

VIII. SUMMARY

It is earnestly requested that the Examiner's rejections be reversed, and that all of the pending claims be allowed.

Please charge any additional fees or credit overpayment to Merchant & Gould Deposit Account No. 13-2725.

Respectfully submitted,

MERCHANT & GOULD P.C.

December 11, 2006
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IX. CLAIMS APPENDIX

1. A method of determining the nitrogen content of a nitrided gate oxide layer on a semiconductor substrate comprising:

nitriding a gate oxide layer on a semiconductor substrate using nitric oxide (NO) gas to form the nitrided gate oxide layer on the substrate;

oxidizing the nitrided gate oxide layer on the substrate, wherein the step of oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the semiconductor substrate;

measuring the thickness of the oxidized nitrided gate oxide layer;

optionally calculating the change in thickness of the oxidized nitrided gate oxide layer; and

determining if the measured thickness or calculated change in thickness of the oxidized nitrided gate oxide layer exceeds a target thickness value.

2. The method of Claim 1, wherein the oxidizing step comprises rapid thermal oxidation of the nitrided gate oxide layer in a rapid thermal processing (RTP) chamber.

3. The method of Claim 1, further comprising correlating the measured thickness or change in thickness of the oxidized nitrided gate oxide layer with the nitrogen content of the gate oxide layer.

4. (Canceled)

5. The method of Claim 1, further comprising forming the gate oxide layer on the substrate prior to the nitriding step.

6. The method of Claim 3, wherein the correlating step comprises:

measuring the oxidized nitrided gate oxide thickness for a plurality of samples each having a known nitrogen content;

optionally calculating the change in thickness after oxidizing the nitrided gate oxide layer for each sample; and

performing a least squares regression analysis to generate a calibration curve for nitrogen content of the nitrided gate oxide as a function of oxidized nitrided gate oxide thickness or change in oxidized nitrided gate oxide thickness.

7. The method of Claim 1, wherein the step of determining the change in thickness of the oxidized nitrided gate oxide layer comprises determining an initial gate oxide thickness by measuring the thickness of the gate oxide layer prior to the oxidation step and calculating the difference between the measured oxidized nitrided gate oxide layer thickness and the initial gate oxide thickness.

8. The method of Claim 7, wherein the initial gate oxide thickness is measured before the nitridation step.

9. The method of Claim 7, wherein the initial gate oxide thickness is measured after the nitridation step.

10. A method of determining the nitrogen content of a nitrided gate oxide layer on a semiconductor substrate comprising:

nitriding a gate oxide layer on a semiconductor substrate using nitric oxide (NO) gas to form the nitrided gate oxide layer on the substrate;

oxidizing the nitrided gate oxide layer on the substrate, wherein the step of oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the semiconductor substrate;

measuring the thickness of the oxidized nitrided gate oxide layer;

calculating the change in thickness of the oxidized nitrided gate oxide layer; and

determining if the measured thickness or calculated change in thickness of the oxidized nitrided gate oxide layer exceeds a target thickness value wherein calculating the change in thickness of the oxidized nitrided gate oxide layer comprises determining an initial gate oxide thickness by estimating the thickness of the gate oxide layer prior to the oxidation step and calculating the difference between the measured oxidized nitrided gate oxide layer thickness and the initial gate oxide thickness.

11. The method of Claim 10, wherein the initial gate oxide thickness is estimated from previously collected gate oxide thickness data.

12. The method of Claim 1, further comprising a step of forming a gate electrode layer over the gate oxide layer.

13. The method of Claim 12, further comprising a step of implanting boron atoms in the gate electrode layer.

14. The method of Claim 12, wherein the predetermined value corresponds to a nitrogen content sufficient to prevent boron atoms from diffusing through the gate oxide layer and into the semiconductor substrate.

15. The method of Claim 1, wherein the oxidation step is conducted at a temperature of 900 to 1025 °C.

16. The method of Claim 15, wherein the oxidation step is conducted for 10 minutes or less.

17. The method of Claim 1, wherein the oxidizing step is performed in the same tool as the nitridation step.

18. The method of Claim 1, wherein the nitridation step is performed in a first tool and the substrate is transferred to a different tool for the oxidizing step.

19. A method for monitoring the nitrogen content of a nitrided gate oxide layer on a semiconductor substrate, the method comprising:

for each substrate in a batch of semiconductor substrates, nitriding a gate oxide layer on the semiconductor substrate using nitric oxide (NO) gas to form the nitrided gate oxide layer on the substrate, oxidizing the nitrided gate oxide layer on the substrate to form an oxidized nitrided gate oxide layer, wherein the step of oxidizing the nitrided gate oxide layer distances the nitrided gate oxide layer away from the semiconductor substrate, and measuring the thickness of the oxidized nitrided gate oxide layer with a film thickness measuring device;

collecting data on the thickness of the oxidized nitrided gate oxide layer for each substrate in the batch on a computer in communication with the film thickness measuring device;

storing the oxidized nitrided gate oxide thickness data for the batch in a data base;

computing a batch average value for the thickness of the oxidized nitrided gate layer;

storing the batch average value on the computer;

repeating steps (a) through (e) above for additional batches of semiconductor substrates;

determining process control limits from the stored batch average values; and

monitoring the nitrogen content by oxidizing a semiconductor substrate having a nitrided gate oxide layer, measuring the oxidized nitrided gate oxide layer thickness and comparing the measured value to the process control limits.

20 – 22. (Canceled)

23. The method of Claim 19, further comprising a step of forming a gate electrode layer over the gate oxide layer and implanting boron atoms in the gate electrode layer.

X. EVIDENCE APPENDIX

A. OFFICE ACTIONS AND AMENDMENTS/RESPONSES

1. Advisory Action, mailed September 5, 2006.
2. Amendment after Final Rejection, filed August 17, 2006.
3. Final Office Action, mailed April 11, 2006.
4. Amendment, filed January 31, 2006.
5. Office Action, mailed October 31, 2005.
6. Amendment accompanying Request for Continued Examination, filed August 23, 2005.
7. Advisory Action, mailed July 1, 2005.
8. Amendment after Final Rejection, filed April 25, 2005.
9. Final Office Action, mailed November 23, 2004.
10. Amendment after Final Rejection, filed October 22, 2004.
11. Final Office Action, mailed July 12, 2004.
12. Amendment, filed April 12, 2004.
13. Office Action, mailed November 10, 2003.
14. Amendment, filed August 26, 2003.
15. Office Action, mailed March 27, 2003.
16. Amendment and Response to Requirement for Restriction/Election, filed January 13, 2003.
17. Requirement for Restriction/Election, mailed December 17, 2002.

B. REFERENCES RELIED UPON BY THE EXAMINER

1. JP 2000-311928.

2. U.S. Patent No. 6,372,581.

3. Wolf *et al.*, "Silicon Processing for the VLSI Era," Vol. 1-3, Lattice Press, California (1990).

4. U.S. Patent No. 5,862,054.

C. REFERENCES CITED BY APPELLANTS

1. Gusev *et al.*, "Growth and characterization of ultrathin nitrided silicon oxide films," *IBM J. Res. Develop.* 43: 265-86 (May 1999).

D. CASES CITED IN THE BRIEF

W.L. Gore & Assoc., Inc. v. Garlock, Inc., 721 F.2d 1540, 1550, 220 U.S.P.Q. 303, 311 (Fed. Cir. 1983).

In re Lee, 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430, 1433 (Fed. Cir. 2002).

In re Keller, 642 F.2d 413, 425, 208 U.S.P.Q. 871, 881 (C.C.P.A. 1981).

In re Spormann, 363 F.2d 444, 448, 150 U.S.P.Q. 449, 452 (C.C.P.A. 1966).

Schering Corp. v. Geneva Pharms., Inc., 339 F.3d 1373, 1378-79, 67 U.S.P.Q.2d 1664, 1667 (Fed. Cir. 2003).

In re Rijckaert, 9 F.3d 1531, 1534, 28 U.S.P.Q.2d 1955, 1957 (Fed. Cir. 1993).

In re Antonie, 559 F.2d 618, 620, 195 U.S.P.Q. 6, 8 (C.C.P.A. 1977).

In re Newell, 891 F.2d 899, 901, 13 U.S.P.Q.2d 1248, 1250 (Fed. Cir. 1989).

In re Grasselli, 713 F.2d 731, 739, 218 U.S.P.Q. 769, 775-76 (Fed. Cir. 1983).

In re Oelrich, 666 F.2d 578, 581-82, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981).

In re Woodruff, 919 F.2d 1575, 1577-78, 16 U.S.P.Q.2d 1934, 1936 (Fed. Cir. 1990).

In re Spada, 911 F.2d 705, 708, 15 U.S.P.Q.2d 1655, 1658 (Fed. Cir. 1990).

In re Geisler, 116 F.3d 1465, 1469, 43 U.S.P.Q.2d 1362, 1365 (Fed. Cir. 1997).

XI. RELATED PROCEEDINGS APPENDIX

None.